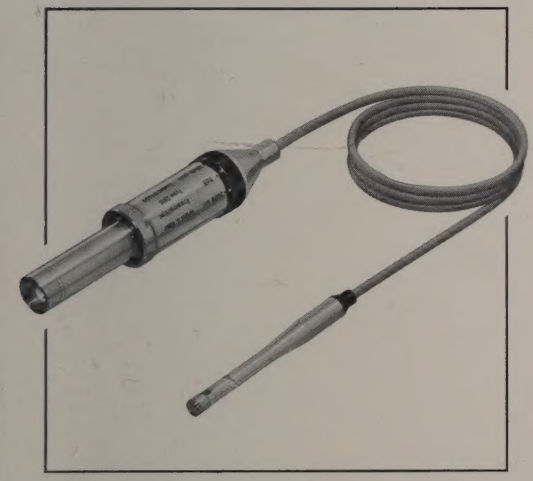
2618

Instructions and Applications



Quarter-inch Preamplifier for Condenser Microphones Type 2618

A field effect transistor preamplifier for the 1/4" and 1/8" microphone cartridges. The extremely high input impedance presents virtually no load to the microphone, ensuring a flat overall frequency response up to 200 kHz. An attenuator switch gives fixed gains of –20, 0, and + 20 dB.

BRÜEL & KJÆR

030 BB 0134

Quarter-inch

Preamplifier for Condenser Microphones

Type 2618

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1. Introduction

1.1. General

The Type 2618 preamplifier, in connection with a B & K 1/4" or 1/8" condenser microphone, makes up a very accurate measuring transducer in the frequency range 5 Hz – 200 kHz, for sonic and ultrasonic applications. Rugged construction and small size make these units ideal for high intensity, wide frequency applications in areas such as jet noise and boundary layer turbulence investigations. The preamplifier can be powered either directly from one of the B & K measuring amplifiers or analysers, or from a microphone power supply. A very low output impedance makes possible the use of long cable connection to analysing or measuring instrumentation, and a gain adjustment enables conditioning of the signal to the optimum level in the cable.

The preamplifier takes the B & K 1/4" microphone cartridge directly, whereas the 1/8" microphone can be used with the UA 0160 adaptor.

It should be noted that the preamplifier cannot be used with B & K Noise Limit Indicators 2211 and 2212.

1.2. Preamplifier Requirements

When a capacitive type transducer such as a condenser microphone, or a piezoelectric accelerometer is used for measuring purposes, it normally must be connected to a high impedance, to preserve the low level signal. This is because the capacitance associated with the transducer is very small, and the capacitance of even fairly short cable lengths can load the transducer to seriously reduce the signal appearing at the other end of the cable.

With miniature condenser microphones the problem of capacitive load is even more serious than with larger microphones or piezoelectric transducers. The capacitive load will cause lower dynamic range, higher distortion and greater danger of rupturing the diaphragm through discharge. A resistive load will cause limitations in the low frequency response.

An equivalent circuit diagram of a microphone and preamplifier input circuit is shown in Fig. 1.1a.

Here $j\omega C_T v_o$ = current supplied by the transducer
v_o = open circuit voltage of the transducer
C_T = transducer capacitance
C_c = cable capacitance
C_p = preamplifier input capacitance
R = preamplifier input resistance

This circuit can be further reduced to Fig. 1.1b where

$$C = C_T + C_c + C_p$$

The voltage v across the preamplifier input can be calculated from

$$v = \frac{j\omega C_T v_o}{j\omega C + \frac{1}{R}}$$

Thus the transmission is

$$\frac{v}{v_o} = \frac{C_T}{C} \frac{j\omega RC}{1 + j\omega RC}$$

At high frequencies $j\omega RC \gg 1$ so

$$\frac{v}{v_o} = \frac{C_T}{C}$$

This means that the transmission ratio is independent of frequency but depends on the total capacitance loading the microphone. It is therefore desirable to reduce this loading as much as possible in order to achieve the highest possible signal to noise ratio. Usually the cable capacitance is avoided altogether by screwing the microphone direct onto the pre-amplifier.

At low frequencies $j\omega RC \ll 1$ so

$$\frac{v}{v_o} = \frac{C_T}{C} j\omega RC$$

giving a drop of six dB per octave as frequency decreases.
The cut-off frequency, – 3 dB point, is where $\omega RC = 1$ or

$$f = \frac{1}{2\pi RC}$$

The cut-off is determined by the combination of preamplifier resistance and the total capacitance. A low cut-off frequency could be obtained by putting in a large capacitance, but as this would mean seriously reduced signal strength

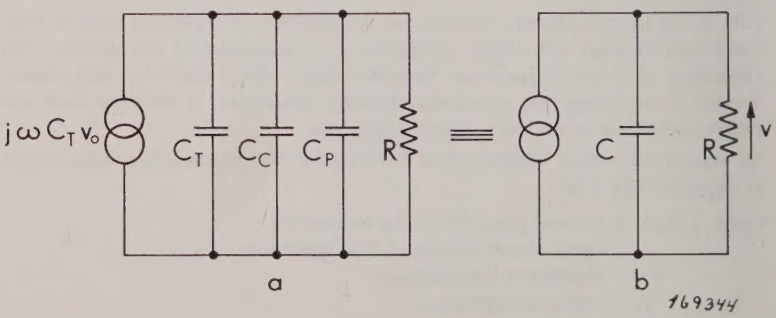

Fig. 1.1a. Equivalent circuit for microphone and preamplifier input circuit.
Fig. 1.1b. Simplified equivalent circuit.

it is necessary to keep *C* as small as possible and strive for the highest possible preamplifier input resistance.
The preamplifier 2618 has an input capacitance of only 0.4 pF and a resistance of 100 GΩ at 20°C. This gives a loss of voltage of only 0.6 dB for a 1/4" microphone. The calculated cut-off frequency is 0.23 Hz, but this cannot usually be utilized as the cut-off of the amplifier stage is about 2 Hz and the mechanical cut-off of the microphone due to the pressure equalization is about 5 Hz. The effective lower limit is of course the highest of these. Specially sealed microphones are available for measurements down to 2 Hz.

2. Description

The preamplifier consists of a field effect transistor input stage contained in the plated brass housing to which a 1/4" microphone can be screwed direct. By means of adaptor UA 0160 the 1/8" microphone cartridge can be used. At the other end of the cable, built as part of the plug, are the remaining stages of the preamplifier. This part contains a booster amplifier for driving long cables. Gains of + 20, 0, – 20 dB are possible by turning a switch. The plug is a 7-pin B & K plug designed to fit B & K measuring amplifiers and analysing equipment in the socket marked CONDENSER MICROPHONE, when all the necessary power supplies will be automatically connected.

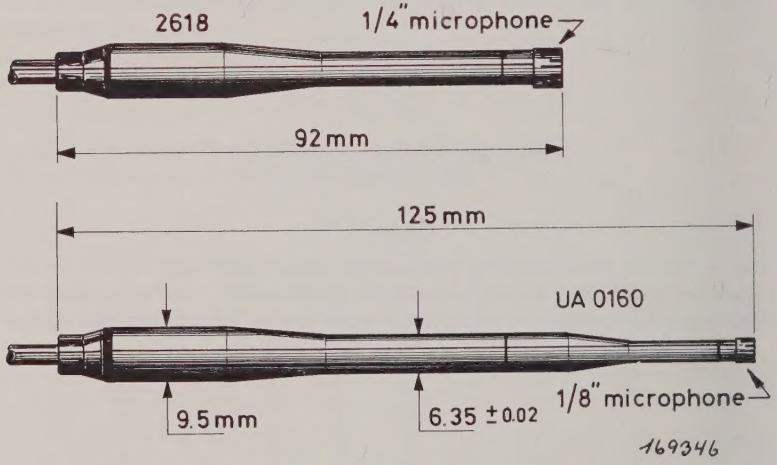

Fig. 2.1. The preamplifier as used with 1/4" and 1/8" microphones.

2.1. Microphones

1/4" (6.35 mm) Type 4135 and 4136.
1/8" (3.175 mm) Type 4138.

2.2. Input Characteristics

Input resistance:	approx. 100 GΩ at 20°C
	> 500 MΩ at 100°C
Input capacitance:	< 0.4 pF

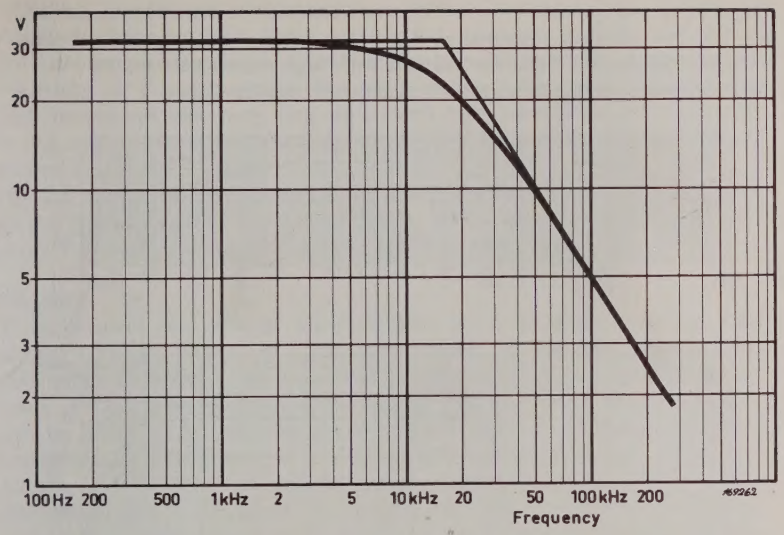

Fig. 2.2. Typical curve of the maximum input voltage (sine, 4 % distortion).

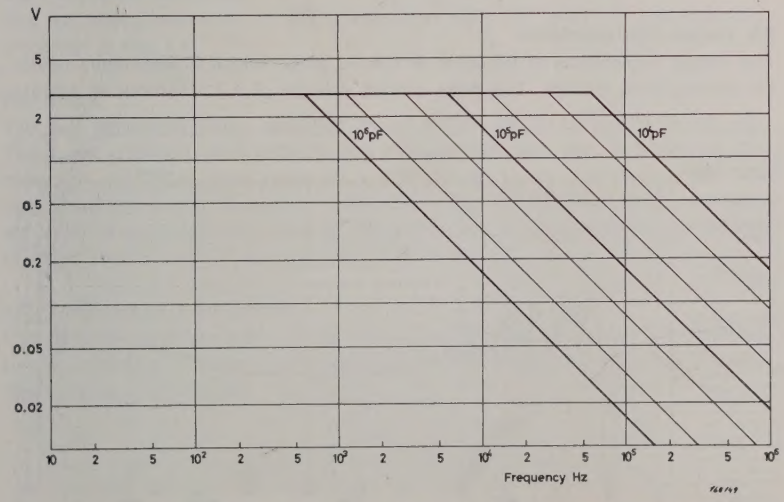

Fig. 2.3. Limitations to the dynamic range of the preamplifier due to capacitive loading.

The 2618 is only suitable for use with small capacitance transducers, the 1/4" and 1/8" microphones in particular. It is not possible to use an accelerometer, since the preamplifier becomes unstable with large capacitance inputs. Maximum input voltage (sine, for 4 % distortion): see Fig. 2.2.

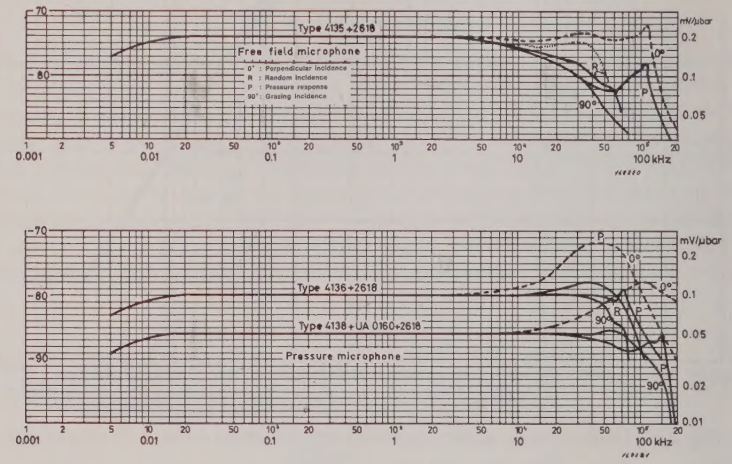

Fig. 2.4. Frequency response with 1/4" and 1/8" microphones.

2.3. Output Characteristics

The output impedance of the 2618 is low, $< 50\ \Omega$, and it is especially useful for driving long cables. The peak output voltage of 4.2 V produces certain

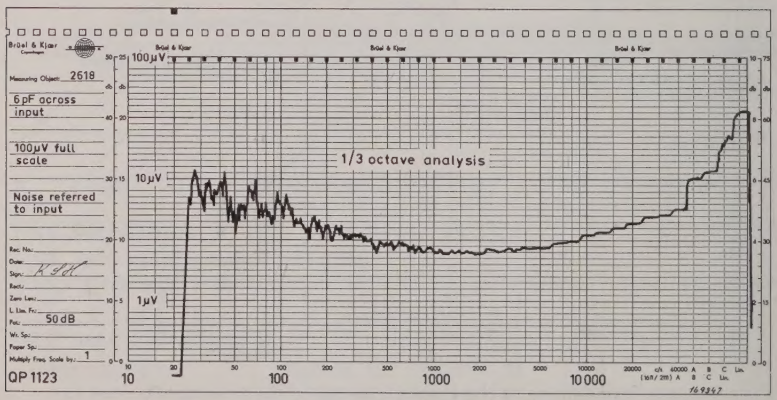

Fig. 2.5. Noise Spectrum, referred to input.

limitations, as also the peak available current of 15 mA. If these figures are exceeded, clipping of the signal occurs, and distortion is introduced. When the load on the amplifier is capacitive, the capacitive current increases with frequency for a given voltage. This effect means that distortion can arise at high frequencies when very long cables, with high capacitance, are connected to the output. The effect is usually not noticed, for normal cable lengths, as shown in Fig. 2.3.
Fig. 2.3 shows the output voltage for the 4 % distortion level of the signal, versus frequency, with cable capacitance as a parameter. Output voltages below the lines given will produce less than 4 % distortion.

2.4. Gain
Three different gain settings are provided, − 20, 0, + 20 dB, ± 0.2 dB. This allows a certain amount of signal conditioning, so that the optimum gain setting can be chosen. The signal can be attenuated when it is of too high a level, and likely to be distorted or clipped, and when it is at a low level it can be amplified for the best signal to noise ratio at the output of an extension cable, and so on.
Additionally the gain will depend on microphone capacitance, due to the attenuation effect described in section 1.2. This attenuation should be calculated in each case from the values of microphone capacitance and the preamplifier input capacitance. (Attenuation = $20 \log_{10} (C_p + C_T)/C_T$ dB).

2.5. Frequency Response
The frequency responses of the preamplifier with 1/4″ and 1/8″ microphones are given in Fig. 2.4.

2.6. Noise
The self generated noise spectrum in 1/3 octave bands is shown in Fig. 2.5. The three different gain settings are represented, and the voltages are referred to the input. Total noise in a band 20 Hz to 40 kHz is shown at the right hand end of the frequency scale, when weighted with A, B, or C networks, and with linear response. A 6.3 pF capacitor has been connected across the input, to simulate a 1/4″ microphone.

2.7. Temperature Environment
The 2618 preamplifier with 1/4″ or 1/8″ microphone will operate satisfactorily in the temperature range − 20°C to + 100°C. No heating coil is built into the microphone end housing.

3. Operation

3.1. Power

The 2618 requires external power supplies, and these are normally connected automatically when the preamplifier is plugged into the CONDENSER MICROPHONE socket of a B & K Microphone Amplifier, or other analyzing equipment, or Microphone power supply.

The pin connections to the plug are shown in Fig. 3.1, in the event that alternative power supply connections are to be used.

The polarization voltage, of 200 V, is connected through a high impedance to the microphone, and draws less than a microamp.

120 V and 12.6 V DC supplies are required for the preamplifier itself.

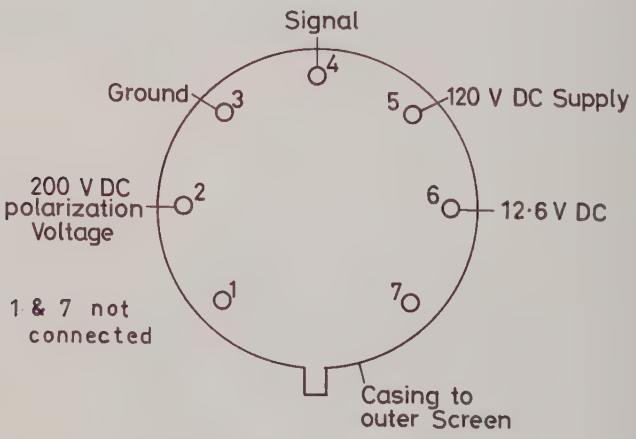

Fig. 3.1. Pin connections, looking at plug from outside.

3.2. Use with other B & K Equipment

1. Microphones and accelerometers. The 2618 is intended to be used as a microphone preamplifier for the 1/4" microphones Types 4135 and 4136 and the 1/8" microphone Type 4138. The latter requires adaptor Type UA 0160. The dynamic ranges of these microphone/preamplifier combinations are:

2618 + 4135:	60 – 174 dB
2618 + 4136:	66 – 180 dB
2618 + 4138 + UA 0160:	65 – 184 dB

The individual microphone open circuit sensitivity is given on the calibration chart supplied with each microphone, and the attenuation produced by the preamplifier must also be allowed for when making accurate measurements. The input capacitance of the preamplifier also produces attenuation with the capacitance of the microphone, as mentioned in Chapter 1.2. Since all these parameters can vary between different units, it is not possible to specify the sensitivity of particular microphone/preamplifier combinations to better than about ± 0.5 dB, and the combination should ideally be calibrated, together with the whole measuring arrangement, if accurate measurements are to be made. The Pistonphone Type 4220 provides a calibrated sound source, and this is recommended as a convenient calibration check for an instrument set-up.
The Type 2618 cannot be used with large capacitance transducers such as accelerometers, since it becomes unstable.

2. Extension cables. Extension cables are available to enable the microphone to be operated remotely from the measuring amplifier. The B & K extension cables are listed in Table 3.1. They can be connected together to make as long a length as required. With very high frequency signals and long cables, the limitations shown in Fig. 2.3 should be noted.

Cable number	Length	Capacitance
AO 0027	3 m	270 pF
AO 0028	10 m	575 pF
AO 0029	30 m	1700 pF

Table 3.1. Extension cables which can be used between preamplifier and power supply or measuring amplifier.

3. Microphone power supply. Two power supplies are available, Type 2801 single channel, and Type 2803 two-channel. They possess a low output impedance, and so can be used at the end of a long extension cable from the measuring amplifier.
The high frequency response will be modified (above 20 kHz) when using these power supplies, and also there is some attenuation. The complete system should be calibrated for accurate measurements of sound pressure level.

4. Measurements and analysis. For measurement of the microphone signal, frequency analysis, etc., all of the B & K range of measurement and analysis instruments can be used, with the 2618 plugged into the CONDENSER MICROPHONE input socket. Power is supplied to the preamplifier via this

socket. The only exceptions to this are the Noise Limit Indicators Types 2211 and 2212, which do not provide the correct voltages for the 2618.

The 20 dB gain setting of the 2618 produces an overall sensitivity on the indicating meter of 10 μV full scale, but this sensitivity can only be used with a narrow bandwidth filter because of the noise generated by the 2618. (See Fig. 2.5, which gives the noise voltages in 1/3 octave bands).

The frequency response of the Type 2603 microphone amplifier is flat up to 40 kHz. The frequency response of the Type 2606 measuring amplifier is flat up to 200 kHz and the low-frequency response extends to 2 Hz as in the Type 2603.

Suitable analysers are the Frequency Analyzer 2107, Spectrometer 2112 or any of the above microphone amplifiers, used with external filter sets. See B & K catalog or data sheets for suitable models.

Note that the maximum output voltage of the preamplifier is 3 V RMS (sine wave), and if necessary use the 20 dB attenuation to avoid distortion.

4. Specifications

Gain:	– 20 dB, 0, + 20 dB ± 0.2 dB
Input Resistance:	Approx. 100 GΩ at 20°C > 500 MΩ at 100°C
Input Capacitance:	< 0.4 pF
Frequency Range:	2 Hz – 200 kHz, see Fig. 2.2.
Output Voltage and Current:	Max. 3 V RMS (sine) 15 mA peak
Output Impedance:	< 50 Ω
Noise:	Self generated noise in wide band (20 Hz – 200 kHz) after 3 to 4 minutes: < 70 μV with 6 pF across input < 120 μV with 3 pF across input
Supply Voltages:	120 V, 12.6 V
Temperature Range:	– 20°C to + 100°C

B & K INSTRUMENTS:

ACOUSTICAL....
Condenser Microphones
Piezo-Electric Microphones
Microphone Preamplifiers
Microphone Calibration Equip.
Sound Level Meters
(general purpose-precision-
and impulse)
Standing Wave Apparatus
Tapping Machines
Noise Limit Indicators

ELECTROACOUSTICAL....
Artificial Ears
Artificial Mouths
Artificial Mastoids
Hearing Aid Test Boxes
Telephone Measuring Equipment
Audiometer Calibrators
Audio Reproduction Test Equip.

STRAIN....
Strain Gauge Apparatus
Multipoint Panels
Automatic Selectors
Balancing Units

VIBRATION....
Accelerometers
Accelerometer Preamplifiers
Accelerometer Calibrators
Vibration Meters
Magnetic Transducers
Capacitive Transducers
Vibration Exciter Controls
Vibration Programmers
Vibration Signal Selectors
Mini-Shakers
Complex Modulus Apparatus
Stroboscopes

GENERATING....
Beat Frequency Oscillators
Random Noise Generators
Sine-Random Generators

MEASURING....
Measuring Amplifiers
Voltmeters
Deviation Bridges
Megohmmeters

ANALYZING....
Band-Pass Filter Sets
Frequency Spectrometers
Frequency Analyzers
Real-Time Analyzers
Slave Filters
Psophometer Filters
Statistical Analyzers

RECORDING....
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Frequency Response Tracers
Tape Recorders

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